College of Arts & Sciences/School of Psychology/Department of Developmental Psychology

Bilingualism, Working Memory, Math Anxiety, and Math Performance

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INTRODUCTION

- Previous studies show a bilingual advantage in working memory capacity (Monnier, et al., 2021)
- There is a positive correlation between working memory capacity and math performance in general population (Ashcraft & Krause, 2007)
- There exists a negative correlation between math anxiety and math performance in the general population (Foley et al., 2017)

AIMS

Specific aim 1: *Examine the relationship between working memory capacity and math performance in the bilingual population*

- Negative linear correlation between working memory capacity and math speed in the target population
- Language of math task as a moderator in this correlation

Specific Aim 2: *Examine the relationship between math anxiety and math performance in the bilingual population*

- Positive linear correlation between math anxiety and math speed in the target population
- Language of math task as a moderator in this correlation

METHODS

Participants

- 46 Chinese-English bilingual college students recruited from Research Experience Program at the Ohio State University; For this study we analyzed data for:
- 44 subjects (N=44, mean age: 19.86, $\sigma = 1.53$; 72.7% males and 27.3% females; 100% Eastern Asian)

Measures

Math performance measure

Arithmetic and algebraic math problems in Chinese and English used in Qin & Opfer, (2018)

Working memory capacity measure

WAIS-III Forward and Backward Digit Span (Kaufman & Lichtenburger, 1999)

Math anxiety measure

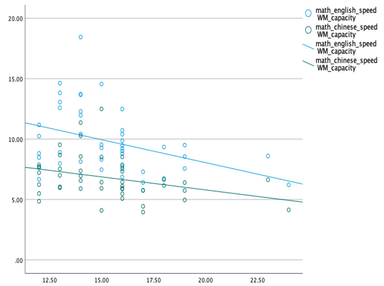
Math Anxiety Rating Scale (MARS-E) (Hopko, 2003)

Statistical analysis

- First, linear regression was employed to examine the linear correlation between math performance and working memory capacity
- Second, regression analysis was employed to examine the moderation effect of the language of the task in this correlation
- Third, linear regression was employed to examine the linear correlation between math performance and math anxiety.
- Fourth, regression analysis was employed to examine the moderation effect of the language of the task in this correlation.

RESULTS

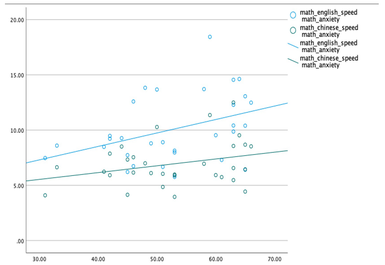
- As expected, **negative correlation** between working memory capacity and math speed (b=-.370, R^2=.137, p=.013) in the target population.
- This correlation is not significantly moderated by the language of the task: there is a negative correlation in the **English** version (b=-.378, R^2=.143, p=.012) and in the **Chinese** version (b=-.323, R^2=.104 ,p=.033).



- There is no significant linear correlation between math anxiety and math speed in the target population

- However, there is a **positive** linear correlation between math anxiety and math speed in the group with **relatively low math anxiety** (MARS-E score ≤ 66) but not in the group with relatively high math anxiety (MARS-E score > 66) (N=30, b=.368, R^2=.135, p=.042).

- This correlation is also moderated by language of the task: it exists only in when the math task is in **English** (b=.391, R^2=.153, p=.030) but not in Chinese.



CONCLUSIONS

Our study was able to identify the following correlations:

- A positive correlation between working memory capacity and math performance in the bilingual population, as stronger when the math task is in the population's second language than in first language.
- A negative correlation between math anxiety and math performance in the bilingual population with relatively low math anxiety, when the math task is in the population's second language.

Overall, our analyses show that the math performance in the bilingual population can be predicted by working memory capacity and math anxiety and that the intersection between the three variables can differ based on the language of the math task as well as math anxiety level of the bilingual.

DISCUSSION

- The positive correlation between working memory capacity and math performance remains the same in the bilingual population as in the general population.
- The negative correlation between math anxiety and math performance was found in the general population, but only under certain conditions in the bilingual population.
- The difference between the findings from the general population and the bilingual population revealed the unneglectable role of language plays in both executive constructs and math performance.
- Future research should focus on the interaction between language and math ability when studying the bilingual population.
- Findings from the study hopefully can guide a better bilingual education practice.

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